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AIR POLLUTION ASPECTS OF EMISSION SOURCES: PRIMARY ZINC PRODUCTION

A BIBLIOGRAPHY WITH ABSTRACTS

ENVIRONMENTAL PROTECTION AGENCY

MARCH 1974

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The Air Pollution Technical Information Center (APTIC) of the Office of Air Quality Planning and Standards prepared, selected, a nd complied the approximately 235 abstracts in this bibliography. The entries are grouped into the following subject categories: emission sources; control methods; measurement methods; air quality measurements; atmospheric interaction; basic science and technology; effects-human health; effects-plants and livestock; effects-economic; standards and criteria and legal and administrative. The subject and author indexes refer to the abstracts by category letter and accession number. The author index list all authors individually; primary authorship is indicated by an astrisk.

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Air Pollution Technical Information Center

ENVIRONMENTAL PROTECTION AGENCY
Office of Air and Water Programs
Office of Air Quality Planning and Standards
Research Triangle Park, North Carolina 27711

March 1974

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INTRODUCTION

The Air Pollution Technical Information Center (APTIC) of the Office of Air Quality Planning and Standards prepared, selected, and compiled the approximately 235 abstracts in this bibliography. The abstracts are arranged within the categories listed in the Contents. The abstracted documents are thought to be representative of available literature, and no claim is made to all-inclusiveness.

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Current information on this subject and many others related to air pollution may be found in APTIC's monthly abstract bulletin.*

All of the documents abstracted by APTIC are currently on file at the Air Pollution Technical Information Center, Office of Air Quality Planning and Standards, Environmental Protection Agency, Research Triangle Park, North Carolina 27711. Readers outside of the U.S. Environmental Protection Agency may seek the documents directly from publishers, from authors, or from libraries.

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*"Air Pollution Abstracts", Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402. Subscription price: $27.00 per year; $6.75 additional for foreign mailing. (More than 6300 abstracts, subject and author indexes are included in each issue, plus two separate indexes.)

A. EMISSION SOURCES

08147

Pakhotina, N. S.

SANITARY-HYGIENIC EVALUATION OF INDUSTRIAL EMISSIONS BY A ZINC-LEAD COMBINE. In: Survey of U. S. S. R. Literature on Air Pollution an Related Occupational Diseases. Translated from Russian by B. S. Levine. National Bureau of Standards, Washington, D. C., Inst. for Applied Tech., Vol. 3, p. 93-97, May, 1960. 6 refs. CFSTI: TT 60-21475

The degree of atmospheric air pollution and vegetation pollution by the discharges of lead-zinc combine and the distance over which such pollution extended was investigated.It should be mentioned at this point that according to N 101-54 the sanitary-clearance zone around lead-zinc combines must be 1000 m wide. The lead-zinc combine under investigation had the following departments; a) premetallurgical production of lead from enriched ore concentrates; b) production of zinc by the continuous and intermittent processes of pyrite cinders leaching and the utilization of tailings, such as zinc cakes, sands, etc.; c) production of sulfuric acid by the contact method from SO2 formed in the process of calcining the zinc concentrates. Samples were collected by the sedimentation and aspiration methods. Determinations were made for lead, arsenic and SO2. Soil samples were analyzed for pH, moisture content, H2SO4, and total lead and arsenic; plant samples were analyzed for lead, arsenic and H2SO4. Samples were taken 150 m to 5,000 m away from the emission source. For control purposes, samples were also taken 16 km away. Industrial discharges of the lead-zinc combine heavily polluted the atmospheric air with SO2, lead and arsenic at all distances from the combine at which samples were taken. The degree of soil and plant pollution with lead and arsenic over the three years of the combine0s operation considerably exceeded the content of lead and arsenic in the soil and on plants of the control region. Under such pollution conditions the prescribed sanitary clearance zone of 1000 m proved inadequate as a sanitary protection measure.

12074

Rohrman, F. A., and J. H. Ludwig

SULFUR OXIDES EMISSIONS BY SMELTERS. J. Metals, 20(12):46, Dec. 1968.

Sulfur dioxide and trioxide are emitted during the roasting and smelting of most copper, lead, and zinc concentrates. The 32 major smelters in the U. S. account for roughly 12.2% of the total emissions of SO2 in the country. This is a brief review of some of the statistics.

12751

McKee, Arthur G. and Co., San Francisco, Calif., Western Knapp Engineering Div.

SYSTEMS STUDY FOR CONTROL OF EMISSIONS. PRIMARY NONFERROUS SMELTING INDUSTRY. (FINAL REPORT). VOLUME II: APPENDICES A AND B. Contract PH 86-65-85, Rept. 993, 88p., June 1969. 72 refs. CFSTI: PB 184 885

A systems study of the primary copper, lead, and zinc smelting industries is presented to make clear the technological and economi factors that bear on the problem of control of sulfur oxide emissions. Sulfur oxide emissions for various types of smelting operations are tabulated, including gas flows and compositions and an analysis of sulfur oxides generation and recovery. Smelter flow diagrams are presented for the control methods of contact sulfuric acid, absorption, reduction to elemental sulfur, lime wet scrubbing, and limestone wet scrubbing. Sulfur oxide recovery processes that were investigated and rejected as not being suitable for economic analysis are listed. Cost estimates for various control processes are given.

12823

McKee, Arthur G. and Co., San Francisco, Calif., Western Knapp Engineering Div.

SYSTEMS STUDY FOR CONTROL OF EMISSIONS. PRIMARY NONFERROUS SMELTING INDUSTRY. (FINAL REPORT). VOL I. Contract PH 86-65-85, Rept. 993, 188p., June 1969. CFSTI: PB 184 884

A systems study of the primary copper, zinc, and lead smelting industries is presented to make clear the technological and economic factors that bear on the problem of control of sulfur oxide emissions. The nature of smelting practice is described, and potential air pollution problems in smelter areas are revealed. Five processes for the control of sulfur oxides are presented, including contact sulfuric acid, absorption, reduction to elemental sulfur, lime wet scrubbing, and limestone wet scrubbing. Current sulfur oxide emissions from U. S. smelters are given, and forseeabl emission trends are discussed. Markets for sulfur byproducts are mentioned, the costs of control by available methods are tabulated, and control method evaluation with plant models is considered. A research and development program for control methods and smelting process technology is recommended.

13814

Coolbaugh, William E. and Ray F. Neider

FLUID COLUMN ROASTING AT SHERBROOKE METALLURGICAL CO., LTD. PORT MAITLAND, ONTARIO. In: Pyrometallurgical Processes in Nonferrous Metallurgy, J. N. Anderson and P. E. Queneau (eds.), Metallurgical Society Conference, vol. 39, Am. Inst. Mining, Metallurgical, and Petroleum Engr., p. 45-54, 1967. (Based on a Symposium sponsored by the Extractive Metallurgy Div. of the Metallurgical Soc., Am. Inst. Mining, Metallurgical, and Petroleum Engr., Pittsburgh, Pa., Nov. 29-Dec. 1, 1965.)

The design of a vertical retort smelter using pelletized feed for roasting and a roaster design based on the New Jersey Zinc Co.'s Fluid Column process is reviewed. By using pelletized rather than sintered feed, the process keeps carry-over dust to a minimum and control of the low sulfate sulfur roast necessary for retort smelting is achieved. The calcine zinc oxide pellets produced yield briquettes equivalent to sintered calcine for zinc smelting, but the process is far less costly than sintering.

The two roasters employed are shaft-type furnaces, approximately 17 ft high and 24 ft long. They are equipped with 32 in. wide hearths, and at the top of the fluid column level they flare at 50 deg angles to a full width of 10 ft. The end walls and the roof of each roaster are integral with the boiler. Fluidizing air is delivered through 6 in. pipelines and distributed to eight wind-boxes below the hearth of each roaster. Draft control of the roasting operation is maintained in an acid plant and with hot fans. The calcine produced during conventional sulfur elimination roasting averages less than 0.5% sulfide and 1.3 to 1.5% total sulfur. With lead-cadmium elimination roasting, 90% of the cadmium and 92% of the lead in the pellet feed can be eliminated. During conventional roasts, dust carry-over amounts to 10 to 15% of the total feed, under lead-calcium elimination conditions, carry-over is increased to 18 to 22% of the feed. Dusts are recovered in boilers, cyclones, and an electrostatic precipitator.

13815

Reid, J. H.

OPERATION OF A 350 TON PER DAY SUSPENSION ROASTER AT TRAIL, BRITISH COLUMBIA. In: Pyrometallurgical Processes in Nonferrous Metallurgy, J. N. Anderson and P. E. Queneau (eds.), Metallurgical Society Conferences, vol. 39, Am. Inst. Mining, Metallurgical, and Petroleum Engr., p. 69-77, 1967. 2 refs. (Based on a Symposium sponsored by the Extractive Metallurgy Div. of the Metallurgical Soc., Am. Inst. Mining, Metallurgical, and Petroleum Engr., Pittsburgh, Pa., Nov. 29-Dec. 1, 1965.)

Prior to the construction of a 350 ton per day suspension roaster, the roasting facilities at Trail consisted of eight suspension roasters, with individual capacities of 150 tons of zinc concentrates per day. Required auxiliary facilities included a wet concentrate conveying system, a dry concentrate conveying and grinding system, waste heat boilers, and a dust recovery system comprising cyclones and an electrostatic precipitator. With the exception of the wet concentrate conveying system, the new installation is completely independent of the older facilities. Its main components are a dry concentrate ball mill, the roaster proper, a calcine ball mill, a calcine slurry tank, waste heat boiler, cyclones, and glass fabric bag house. Most of the related equipment is installed in duplicate on opposite sides of the roaster. Operation at rated capacity requires the use of all equipment; operation at 60% capacity is possible with only one half of it. Sulfur dioxide is recovered economically by means of gas recirculation. The recirculating combustion gases are cooled in passing through the waste heat boiler and cleaned in the bag house, whose operation is completely automated. Dust loss with the glass fabric bag house is on the order of 174 lbs a day, representing a recovery of 99% of the dust load entering the bag house.

17471

Knop, Wilhelm

INDUSTIRAL DUSTS AND WASTE GASES. (Industri-estauebe und-abgase). Text in German. Wasser Luft Betrieb, 14(2):63-66, Feb. 1970. 22 refs.

The most dangerous and annoying pollutants emitted by various industries are enumerated. Steel mills emit primarily iron oxides and fluorine compounds. Half of the original fluorine input is emitted; the other half goes into the slag. The iron oxide emissions, primarily the small particles below 5 micron, form the brown smoke. The non-ferrous metal fabricating and finishing plants emit metal oxides (cadmium oxide). When inhaled, the latter may be extremely harmful. The TLV (threshold limit value) is 0.1 mg/cu m air. In aluminum production, dust-laden waste gases develop, despite the wet process. The aluminum oxide dust content in the rotary furnace is 300-400 g/standard cu m. In electrolytic reduction of aluminum oxide, cryolite also dissociates. As a consequence, hydrogen fluoride and dusts of fluorine compounds are found in the waste gas. The TLV for fluorides is 2.5 mg/cu m; for hydrogen fluoride, 2 mg/cu m. In lead plants 3 to 3.5 cu m waste gases per kg sinter develop in the sintering and roasting station. They contain 1.5 to 5% by volume SO2 and up to 15 g/cu m dust. The dust contains lead, zinc, sulfur, and small amounts of other elements. Considerable amounts of metal vapors develop. In the fly dust of the shaft furnaces, cadmium oxide or sulfate, arsenic, zinc, and thallium compounds may be found. In copper smelting plants, the waste gases contain fly dust and SO2. In zinc refining, fly dust (0.1 g/standard cu m) and SO2 are emitted to the waste gas. In ferro-alloy production, dusts of various kinds are carried along in the waste gases. The waste gas quantity of a 10 MW furnace amounts to 70,000-250,000 cu m/h; the dust content, to 0.25-2.5 g/cu m.

24285

Swain, Robert E.

SMOKE AND FUME INVESTIGATIONS. A HISTORICAL REVIEW. Ind. Eng. Chem., 41(11):2384-2388, Nov. 1949. 18 refs.

Several outstanding cases of injury to animal and plant life by emanations from industrial plants at Ducktown, Tenn., Anaconda, Mont., Salt Lake City, Utah, and Trail, B. C. are cited in a historical survey of atmospheric pollution and the steps that have been taken to prevent and combat it. Sulfur dioxide from two copper smelters was the offender in Ducktown, reaching for 30 miles across the broad-leafed forests of northern Georgia. A crisis came when Georgia brought suit against Tennessee to compel it to cancel the franchise of the smelting companies, but out of this came the design, erection, and successful operation of an adaptation of the lead chamber process to convert SO2 from copper smelting operations to sulfuric acid. With the installation at the Anaconda smelter in 1910 of an enormous Cottrell system for electrical precipitation of solids, one of the most remarkable cases of injury to livestock by smelter smoke ever recorded passed into history. The emissions from the low stacks of an old plant operated at a neighboring location had killed all vegetation, and losses of livestock by arsenical poisoning had been heavy over the near-lying area. A new smelter was erected with stacks over 300 feet tall, but there were still emitted daily 2300 tons of SO2, 200 tons of sulfur trioxide, 30 tons of arsenic trioxide, 3 tons of zinc, and over 2 tons each of copper, lead, and antimony trioxide. Lead and SO3 fumes were soon put under complete control in Utah by liming and bag filtration, and by electrical precipitation. About $13,000,000 was invested at Trail in recovering airborne wastes and converting them to marketable by-products. These were tied together into a smoothly operating system and soon phosphate fertilizers of several types, ammonium sulfate, and sulfur were being produced on a large scale. Contributions of research and diurnal fumigation are also discussed.

25178

Teworte, W. M.

SPECIFIC AIR POLLUTION CONTROL ARRANGEMENTS AT NON-FERROUS METAL WORKS. Preprint, International Union of Air Pollution Prevention Associations, 41p., 1970. 20 refs. (Presented at the Internationa Clean Air Congress, 2nd, Washington, D. C., Dec. 6-11, Paper EN-28B.)

Information on the cost problem and on the necessity for air pollution control technology in the field of non-ferrous metals production is presented. Their price, high in comparison with that of steel, is an incentive to developing any means of increasing the yield and, thus, to recovering the metals from flue dusts. Therefore, the center of air pollution control arrangements shifts to the side of extracting accompanying elements in the ores, auxiliary materials, and highly volatile compounds. The negative biological effects of a large number of metals require particularly effective arrangements for waste gas purification. More recent specific methods of air pollution control are illustrated by several examples. Fluorine emissions from the flux are fought in aluminum works by means of effective wet purification processes; dry absorption methods are also being tried. Fluorine levels of 0.5-1.5 ppb were detected even in industrial areas where there was no aluminum production at all. Waste gas purification at aluminum re-melting works presents a particularly difficult problem with regard to the extraction of very fine salt fumes. The utilization of the sulfur content in the non-ferrous metal ores is discussed in detail. Here, the solution to the economic problem of marketing a sulfuric acid, aptly called 'acide fatal' by Belgian smelting works, is as important as the solution to the process-technical problem. The latter was dealt with very successfully by means of the development of a double-contact process with intermediate absorption for roasting gases poor in sulfur dioxide. The final gases contain less than 0.5% of the SO2 charge. More and more processes favorable to air hygiene are being used by zinc metallurgy. Methods of recovery that cannot be controlled by waste gas technology, will be discarded. General and particular information is given on the cost problem of air pollution control. Frequently, the wrong conclusions are drawn from the fact that only 0.2% of the value of industrial production are required for direct steps, with secondary injurious effects, amounting to 1-2%, being prevented in this manner. Production at some works is hard hit by specific costs of 1-5% of the proceeds from sales. (Author abstract)

26441

Oglesby, Sabert, Jr. and Grady B. Nichols

A MANUAL OF ELECTROSTATIC PRECIPITATOR TECHNOLOGY. PART II -- APPLICATION AREAS. Southern Research Inst., Birmingham, Ala., NAPCA Contract CPA 22-69-73, 875p., Aug. 25, 1970. 118 refs. NTIS: PB 196381

The application of electrostatic precipitators is reviewed for the electric utility industry, the pulp and paper industry, the iron and steel industry, the rock products industry, the chemical industry, in cleaning municipal incinerator dusts, for the petroleum industry, and in the nonferrous metals industry. Particular emphasis is placed on the dust and gaseous emissions of the processes discussed. This is followed by a tabulation of input and design parameters for precipitators operating on various types of dust control problems and an analysis of critical design parameters and test results. Cost data are also presented. The electrolytic reduction of aluminum, the production of copper, primary lead, and zinc reduction are discussed in the area of the nonferrous metals industry. In the petroleum industry, catalytic cracking and detarring are indicated as application areas. Refuse properties are discussed, as well as types of incinerators. Sulfuric acid production, the production of elemental phosphorus, phosphoric acid, and carbon black, warrant the use of precipitators in the chemical industry. In the rock products industry, the manufacture of Portland cement and the gypsum industry present problems. Coke ovens, sinter plants, blast furnaces, open hearth furnaces, basic oxygen converters, electric arc furnaces, scarfing machines, and iron cupolas are areas of application in the iron and steel industry. In the pulp and paper industry, precipitators are indicated for the recovery of boiler particulate emissions and sulfate process flue gases. Fly ash precipitators are needed in the electric utility industry.

29539

Eda, Shizuo, Hiroshi Ito, Hiroshi Hikichi, Yoshiichi Funayama, Shijeo Nagayama, and Kaoru Nishiyama

HEAVY METAL POLLUTION IN THE ONAHAMA INDUSTRIAL AREA. 1ST REPORT. DISTRIBUTION OF HEAVY METALS IN SOIL. (Onahama kogyo chitai niokeru jukinzoku osen. Dai 1 po. Dojo no jukinzoku osen bunpu to sono kento). Text in Japanese. Fukushima Kogyo Koto Senmon Gakko Kiyo (Mem. Fukushima Tech. Coll.), 7(1):22-32, 1971. 15 refs.

The amount of heavy metal pollution in the Onahama industrial area soil was determined by an atomic absorption spectrometer. The concentration of cadmium, lead, copper, and zinc was 1.07 to 0.27 ppm, 51 to 12 ppm, 65.7 to 12.6 ppm, and 172.4 to 35.1 ppm respectively. The metal ratio Cd:Pb:Cu:Zn was 1:48:65:170. This pollution occurred more than two km from A refinery and was caused by the high stacks of the A and B refineries. The rate of cadmium compound sedimentation at Minamitomioka village in Onahama was 36 mg Cd metal/sq m, year. If the present rate of pollution continues, the heavy metal concentration in the soil would be about three times the present concentration in 10 years. The quality grade of ore and the heavy metal ratio in the soil are used to determine whether copper or zinc is a greater pollutant.

29572

Paluch, Jan and Stanislaw Karweta

AIR POLLUTION BY LEAD AND ZINC IN THE AREA OF COMBINED METALLURGICA WORKS AND ITS INFLUENCE ON VEGETATION AND SOIL. (Die Luftverunreinigung durch Blei und Zink im Bereich eines metallurgischen Kombinates und ihr Einfluss auf Vegetation und Boden). Text in German. Wiss. Z. Humboldt Univ. Berlin Math. Naturw. Reihe, 19(5):495-497, 1970.

A study was made for over three years in the area of a large non-ferrous metals plant that started operations in 1966, and which was located in a formerly very clean wooded area. Its production includes zinc oxide and lead; by-products include sulfuric acid and ammonium sulfate. The zinc oxide melting furnaces emit about 30 tons of gas per month, containing about 50% zinc plus lead. Additional quantities of zinc and lead dust in the air originate from the charging of the furnaces with powdered raw material, from transportation and handling of scrap material, from the sintering plant for zinc-lead ores, and from the shaft furnace in which the metal oxides are reduced to metals. A distinct increase in dust fall and air pollution in the areas adjacent to the plant was observed, reaching a peak two years after start of operations, and then leveling off. Emission of zinc- and lead-bearing dust into th air was found to cause an accumulation of these metals in the soil and in plants, the accumulation in the soil was observed only in the surface layers. The emission of zinc and lead from the melting units takes place mainly in the form of oxides which are emitted together with considerable quantities of calcium oxide. The accumulation of these three metal groups leads to soil alkalinity. The process of assimilation of zinc and lead in plants is far more intensive than in the soil.

30447

Nelson, Kenneth W.

NONFERROUS METALLURGICAL OPERATIONS. In: Air Pollution. Arthur C. Stern (ed.), Vol. 3, 2nd ed., New York, Academic Press, 1968, Chapt. 37, p. 171-190. 16 refs.

While sulfur dioxide from the smelting of copper, lead, and zinc has been the principal pollutant of interest in nonferrous metallurgy, gaseous and particulate fluorides from aluminum smelting are also of concern. Fluoride problems first came to attention because of adverse effects on grazing animals rather than effects on vegetation, as with SO2. The mining, milling, and concentrating of copper, lead, and zinc are discussed, as well as their refining and smelting, emissions, and controls. The mining and ore treatment of aluminum is considered, its electrolysis, and emissions and controls. Copper, lead, zinc, and aluminum produced from scrap are also discussed. The production of nonferrous alloys is noted.

30647

Ministry of International Trade and Industry, Tokyo (Japan)

INSPECTION RESULTS OF CADMIUM MINES AND REFINERIES. 1970. (Kadomyumu kanren kozan seirensho no 45 nendo kensa kekka nitsuite). Text in Japanese. Sangyo Kogai (Ind. Public Nuisance), 7(5):250-257, May 1971.

Mines and smelters which handle zinc, copper, or lead were inspected. It is important to control the overall effluent so that its cadmium concentration is within the allowable limit of (0.1 ppm). Of 62 mines inspected, two exceeded the limit with 0.542 ppm and 0.145 ppm respectively. To indicate the individual effluent condition, the maximum and minimum concentrations are shown in tabular form. Three other mines also exceeded the 0.1 ppm limit with 0.125 ppm, 0.14 ppm, and 0.195 ppm, respectively. However, the overall effluent showed less than the standard concentration. Strong supervision is recommended to reduce the seepage from old piles and to reduce the individual effluent at each pit and pile. Two smelters exceeded the standard, with 0.175 ppm and 0.111 ppm, respectively. The water near several mines and smelters was sampled, and four mines exceeded 0.01 ppm. The atmospheric cadmium concentration was also measured. Even under the most unfavorable condition, all were within the standard of 0.88 micrograms /cu m -2.93 micrograms /cu m. The mines and smelters which exceeded the standard were directed to close the pit, repair defective water discharge facilities and neutralize the seepage. A thorough study will be made to clarify environmental pollution by cadmium, distinguishing it from complex pollution.

32567

Dean, R. S. and R. E. Swain

REPORT SUBMITTED TO THE TRAIL SMELTER ARBITRAL TRIBUNAL. PART 1 OPERATIONAL FEATURES OF TRAIL SMELTER. Bull. Bureau Mines, no. 453:1-22, 1944. 5 refs.

The Trail Smelter Arbitral Tribunal, with powers derived from a convention between the U. S. and Canada, was established to determine whether fumigations from the Trail Smelter in British Columbia were a source of vegetation damage in the State of Washington and, if so, what indemnity should be paid for damages incurred since January 1932. Both lead and zinc concentrates are roasted at Trail, and nearly all the sulfur is converted to sulfur dioxide gas during this process. In 1930, SO2 emissions from the plant reached approximately 20,000 tons/month. Subsequently, emissions were reduced by the construction of sulfuric acid plants, absorption plants, and a sulfur-reduction unit. A detailed description is given of the various smelting operations at Trail and of the sulfur-recovery operations. General topographic and climatic features of the region are briefly reviewed together with smoke-control measures. Data on the total tonnage of sulfur discharged from the plant per month from 1900-1939 are presented.

34788

Proctor, Paul Dean and Thomas R. Beveridge

POPULATION, ENERGY, SELECTED MINERAL RAW MATERIALS, AND PERSONNEL DEMANDS, 2000 A. D. Preprint, Society of Mining Engineers, AIME, N. Y., New York, N. Y., 19p., 1971. (Presented at the American Institute of Mining, Metallurgical, and Petroleum Engineers, Annual Meeting, New York, Feb. 26-March 4, 1971, Paper 71-H-107.)

The people of the United States currently consume 32% of the world s energy and similarly large percentages of the world s mineral raw materials. A minimal two percent increase per year in the standard of living in the United States and a four percent increase elsewhere in the world, beyond the demands of the estimated population increases, suggest the magnitude of the increased need for energy-mineral raw materials and the possible crises the world will face in these areas by 2000 A.D. Iron ore, copper, lead, and zinc, sulfur, and fertilizer consumption and projections are considered. Better trained and increased manpower needs are also indicated.

34916

Bureau of Census, Washington, D. C.

PRODUCT CLASSES - VALUE SHIPPED BY ALL MANUFACTURING ESTABLISHMENTS: 1947, 1954, 1958, 1963 TO 1967. In: Smelting and Refining of Nonferrous Metals and Alloys. p. 33C-29, 1970.

Quantities shipped by all manufacturing establishments of copper, lead, zinc, aluminum, primary nonferrous metals, and secondary nonferrous metals are tabulated for 1947, 1954, 1958, and 1963 to 1967. Both smelter and refined materials are included.

34921

Bureau of Census, Washington, D. C.

MATERIALS CONSUMED, BY KIND: 1967 AND 1963. In: Smelting and Refining of Nonferrous Metals and Alloys. p. 33C-31, 1970.

The quantity consumed in the smelting and refining of nonferrous metals and alloys of aluminum ingot, aluminum and aluminum-base alloy scrap, copper, lead, zinc, and tin is listed for 1963 and 1967. Delivered costs are also indicated.

35224

Halley, James H. and Bruce E. McNay

CURRENT SMELTING SYSTEMS AND THEIR RELATION TO AIR POLLUTION. Preprint, American Inst. of Chemical Engineers New York and Inst. Mexicano de Ingenieros Quimicos, 20p., 1970. 5 refs. (Presented at the American Institute of Chemical Engineers and Institute Mexicano de Ingenieros Quimicos, Joint Meeting, 3rd, Denver, Colo., Aug. 30-Sept. 2, 1970.)

The non-ferrous smelting operations, using metallic sulfides as feed material, are briefly described. These include copper, lead, and zinc smelting. Conditions and the nature of waste gas streams are discussed in relation to extraction and recovery of sulfur. Major problems of high temperatures, unclean gases, and low sulfur oxide concentration are noted.

Possible changes in equipment and processes are discussed, as well as the manufacture of sulfuric acid from relatively strong sulfur dioxide waste gas. (Author abstract modified)

39462

Midwest Research Inst., Kansas City, Mo.

PARTICULATE POLLUTANT SYSTEM STUDY. VOLUME III - HANDBOOK OF EMISSION PROPERTIES. Air Pollution Control Office Contract CPA 22-69-104, MRI Proj. 3326-C, 626p., May 1, 1971. 302 refs.

Details of the methodology employed to obtain data concerning the kind and number of stationary particulate sources, the chemical and physical characteristics of both the particulates and carrier gas emitted by specific sources, and the status of current control practices, are presented. Emission factors and rates, chemical and physical properties of effluents, and control practices and equipment are given for stationary combustion processes (power generation and furnaces); mineral processing; agricultural operations (field burning, grain elevators, cotton gins); iron and steel manufacturing; cement manufacturing; forest products industry (sawmills, pulp industry); primary nonferrous metallurgy (copper, lead, zinc, and aluminum smelting and refining); clay products; fertilizer manufacturing; asphalt; ferroalloy manufacturing; iron foundries; secondary nonferrous metals industry; coal preparation; carbon black manufacturing; petroleum refining; acid manufacture (sulfuric acid and phosphoric acid); and incineration. The control equipment includes cyclones, wet scrubbers, electrostatic precipitators, fabric filters, mist eliminators, and afterburners. Effluents include dusts, particulates, fly ash, sulfur oxides, hydrocarbons, and other noxious gases. Costs for control equipment purchase and operation are given. This handbook constitutes a reference source for available information on the distinguishing features of the various particulate pollution sources and should be of value to air pollution regulatory agencies, control equipment manufacturers, and industrial concerns.

40182

Takahashi, Noboru

ENVIRONMENTAL POLLUTION BY METAL INDUSTRIES. (Kinzoku sangyo ni yoru kankyo osen). Text in Japanese. Kagaku (Science), 41(10):551-556, Oct. 1971.

Iron works produce mineral powder and coke powder as particulates and sulfur dioxide. More than 50% of the SO2 is from the sintering process. By an approximate calculation, a plant with a capacity of annual production of 1000 tons crude steel produces 7,000,000 cu m SO2 every year. The SO2 gas from an iron works also contains extremely poisonous arsenic trioxide. The same plant discharges about 2400 tons of waste water yearly. Casting industries generate approximately 6000 tons of particulates yearly, of which about 50% are silicon dioxide. In zinc production industries, cadmium is generated since its contamination in zinc mineral is approximately 0.25%. It is discharged as dust into air and as waste in waste water. In aluminum refining, fluorides are generated, and for a production of 1 ton aluminum about 20 to 30 kg of fluorine are also produced as fluorides. Cyanides are largely used in metal gilding and thermal treatment, approximately 50% for the former and 30% for the latter. These cyanides, accompanied with cadmium, have been the major pollutants in the rivers in large cities.

42225

Montague, H. L.

THE EXTRACTIVE METALLURGY OF ZINC. REVIEW OF PROCESSES AND PROJECTIONS FOR THE FUTURE. Preprint, American Inst. of Mining, Metallurgical and Petroleum Engineers, New York, Metallurgical Society, 53p., 1971. 7 refs. (Presented at the American Institute of Mining, Metallurgical and Petroleum Engineers, Annual Meeting, 100th, New York, Feb. 26-March 4, 1971, Paper A71-74.)

The history of zinc extractive metallurgy is reviewed, and the five prinicipal processes presently used for the primary production of zinc are described. They are the horizontal retort process, the vertical retort process, the electrothermic process, the imperial smelting process, and the electrolytic process. Free World zinc plants are listed by process type, with information on starting dates, operating features, production capacities, and 1969 zinc production. Three major factors which are likely to affect the type of processes used and the design of future plants are labor difficulties, the tightening of impurity specifications by customers, such as the die-casting industry and the continuous galvanizing industry, and pollution control regulations, restricting sulfur dioxide and particulate emissions. Several plants currently under design or construction are described.

42676

Ministerium fuer Arbeits, Gesundheit und Soziales des Landes Nordrheim-Westfalen, Duesseldorf (West Germany)

NONFERROUS METALLURGY. (NE-Metallerzeugung). Text in German. In: Reine Luft fuer morgen. Utopie oder Wirklichkeit. Moehnesee- Wamel, West Germany, K. ron Saint George, 1972, p. 60-65.

The present situation and future trends in the output and emissions in the nonferrous metallurgy of North Rhine-Westphalia are described. The aluminum industriy, which accounts for more than 50% of the total output of West Germany, will experience rapid growth. The basic pollutants are gaseous fluorine compounds (0.8-1.5 kg/t), aluminum- and fluorine-bearing dust (9-20 kg/t), sulfur dioxide (3-15 kg/t), and carbon monoxide. Aluminum remelting is expected to increase 100% by 1980. Chloride aerosols, metal oxides, and gaseous fluorine compounds are the chief pollutants. Dust separation at a rate of 15% was applied to rotary furnaces in 1970. Dust emissions will decrease from 1320 tons in 1970 to 680 tons in 1980 by lowering the dust concentration to 150 mg/N cu m and 100 mg/N cu m for rotary furnaces and thermal chips treatment facilities, respectively. Gaseous fluorine emissions, 90 tons in 1970, will be reduced to 50 tons in 1980 by applying wet-type gas cleaning. Sulfur dioxide emissions from lead manufacturing will be reduced 90% due to waste-gas desulfurization. The efficiency of SO2 separation at sulfuric acid production facilities is 98%. Lead and zinc emissions, amounting to 350 and 180 tons in 1970, will decrease to 50 tons each in 1975. Sulfur dioxide emissions from copper manufacturing, for which a 2% yearly rate of growth is predicted, will rise from 900 tons in 1970 to 1100 tons in 1980, the waste-gas SO2 concentration being 0.2 g/N cu m. Hydrochloric acid emissions, now 500 tons, will decrease by 50%. While total dust emission will be reduced from 600 to 300 tons, no further reduction in lead, zinc, and copper emissions is possible. The dust emissions from copper alloy manufacturing will be 10% of the 1970 level by 1980, as an upper limit of 50 mg/N cu m will be set in 1973. Sulfur dioxide emissions from zinc manufacturing, for which electrolytic processes are increasingly used, will decrease from 1800 tons in 1970 to about 1500 tons in 1980. The imposition of a maximum allowable dust emission of 50 mg/N cu m in 1973

will result in zinc and lead emissions, now 160 and 40 tons, decreasing to 80 and 20 tons, respectively, despite a growth rate of 40%.

43271

Environmental Protection Agency, Research Triangle Park, N. C., Office of Air Programs

METALLURGICAL INDUSTRY. In: Compilation of Air Pollutant Emission Factors. OAP Pub-AP-42, p. 7-1 to 7-22, Feb. 1972. 61 refs. NTIS: PB 209559

Primary and secondary metal industries are discussed. The primary industries, producing metals from ore, reviewed are: non-ferrous operations of aluminum ore reduction, copper smelters, lead smelters, zinc smelters, iron and steel mills, ferroalloy production, and metallurgical coke manufacture. Large quantities of sulfur oxides and particulates are emitted by these industries. The secondary metallurgical industries, which recover metal from scrap and salvage and produce alloys from ingot, include aluminum operations, brass and bronze ingots, gray iron foundries, lead smelting, magnesium smelting, steel foundries, and zinc processing. The major air contaminants from these operations are particulates in the forms of metallic fumes, smoke, and dust. Control methods used are: cyclones, electrostatic precipitators, filters, and baghouses.

44781

Davis, W. E.

NATIONAL INVENTORY OF SOURCES AND EMISSIONS. BARIUM, BORON, COPPER, SELENIUM, AND ZINC. SECTION V. ZINC. Davis (W. E.) and Associates, Leawood, Kans., Office of Air Programs Contract 68-02-0100, 77p., May 1972. 26 refs. NTIS: PB 210680

The flow of zinc in the United States was traced and charted for the year 1969. Consumption was 1,797,000 tons, while primary and secondary production totaled 1,417,000 tons. Imports and exports were 354,000 and 43,000 tons, respectively. Ore used directly in processing was 127,000 tons. Emissions to the atmosphere during the year were 159,922 tons. About 31% of the emissions resulted from the metallurgical processing of zinc, more than 3% from the production of iron and steel, and nearly 18% from the incineration of refuse. The production of zinc oxide, the wear of rubber tires, and the combustion of coal were also significant emission sources. Emission estimates for mining, production of primary and secondary zinc, manufacture of zinc- base alloy products, and the production of zinc oxide are based on unpublished data obtained from industrial sources. (Author summary)

45858

Lukey, Michael E. and M. Dean High

EXHAUST GAS CONVERSION FACTORS. Preprint, Air Pollution Control Assoc., Pittsburgh, Pa., 16p., 1972. (Presented at the Air Pollution Control Assiciation, Annual Meeting, 65th, Miami, Fla., June 18-20, 1972, Paper 72-88.)

The exhaust gas parameters from 76 combustion and industrial sources are given including fuel combustion processes, refuse incineration, mineral industries, chemical industries, metallurgical processes, pulp mills, and refineries. The main objective of the study was to define a relationship of the exhaust gases being emitted, to the process weights. Each of the 76 industrial source factors includes a process description, the potential air contaminants, operating time, abatement equipment, an input-output relationship, and the exhaust gas parameters: gas flow rate, gas temperature, gas velocity, and stack height. An attempt was made to relate the exhaust gas parameters to an input or output quantity. Thus by knowing the production rate of a plant, one can use these exhaust gas source factors and pollutant emission factors to obtain engineering estimates of specific plant emission and its community inpact through modeling. Sources include coal, oil, natural gas, and wood combustion, incineration; burners; chemical processes such as ammonia, carbon black, chlorine, hydrofluoric acid, paint, phosphoric acid, plastics, ink, soap, sulfuric acid, synthetic fibers, and rubber production; food and agricultural processes; primary metallurgy; steel, lead, zinc, and aluminum production including sintering, blast furnaces, electric furnaces, and open hearth furnaces; petroleum refining, pulp mills; dry cleaning; and surface coating.

B. CONTROL METHODS

06091

G. A. Johnson, R. E. Lund, K. F. Peterson

AIR POLLUTION PREVENTION AT A MODERN ZINC SMELTER. Air Repair 3 (3), 173-8 (Feb. 1954).

Throughput is of the order of 600 tons of zinc sulfide concentrates per day. The acid plant consists of three gas purification systems and four contact units. Concentration of sulfur dioxide in the stack gases is approximately 0.01% by volume. Sinter and furnace plant dusts and fumes are collected in a 275,000 cfm bag collector which discharges to a 168' stack. In all there is a capacity of about 1,000,000 cu. ft. per minute of air cleaning equipment in operation at Josephtown. The agglomeration of roaster calcines by sintering results in the evolution of large quantities of fume rich in zinc, cadmium, and lead. The electrostatic precipitators at Josephtown comprise probably the largest installation for this application of fume collection in the zinc industry. Conditioning is achieved by treating the gases in chambers prior to the precipitator with large quantities of finely atomized water. Two cyclone scrubbers further threat sintering gases before venting. The overall removal of fume from the sintering gas is of the order of 95% with a concentration in stack gases of approximately .02 grains per cu. ft. STP. Effective control of dust and fume (other than that from the sinter machines) at Josephtown is accomplished with a central cloth bag collector of 275,000 cu. ft. per minute capacity. Over 100 tons of dust are removed from the 11,000 tons of air which are cleaned every day. The dust loading entering the collector is about four grains per cu. ft. and the collector operates at better than 99.9% efficiency. Individual points of dust and fume generation are hooded or enclosed as completely as possible and exhausted to the collection system. Measurements of SO2 in the vicinity of the smelter are reviewed.

10558

Lange, Alfred and Werner Trinks

THE ELECTRICAL RESISTANCE OF LEAD AND ZINC COMPOUNDS, WITH SPECIAL REFERENCE TO THE GAS PHASE. APPLICATIONS TO ELECTROSTATIC GAS CLEANING. ((Der elektrische Widerstand von Blei- und Zinkverbindungen unter besonderer Berucksichtigung der Gasphase. Ein Beitrag zum Problem der elektrischen Gasreinigung.)) Text in German. Neue Heutte, 12(2):81-88, Feb. 1968. 8 refs.

The use of electrofilters in dust elimination from flue gases in nonferrous metallurgy in many cases is attended by failure due to the poor conductivity of the dust deposited on the filter electrodes. Hence, the determination of the electrical resistance of particular dust types is of interest. The literature on this subject is reviewed and original resistance measurements are reported which utilized a specially constructed apparatus permitting gas phase measurements up to temperatures of 400 degrees C. Electrical resistance measurements of lead oxide, carbonate and sulfide are described and illustrated by graphs. The results of these measurements and of deposition experiments with lead oxide and lead sulfate fly ash are detailed. At high temperatures the resistance of lead and zinc compounds lies below the critical limit, thus deposition in a hot-gas atmosphere (EGR) is possible in principle; however, larger quantities of gas and larger filters are consequently required. The reported results suggest that lead oxide fly ash should be deposited in the temperature range of 320 and 380 degrees C., and lead sulfate fly ash at temperatures above 350 degrees C. During the deposition of lead oxide fly ash, the partial oxygen pressure of the gas phase should be as high as possible, in contrast to the conditions required for zinc oxide fly ash. In the deposition of lead sulfate fly ash, especially, the constant presence of SO2 in the gas phase is essential.

21309

Argenbright, L. P. and Bennett Preble

SO2 FROM SMELTERS: THREE PROCESSES FORM AN OVERVIEW OF RECOVERY COSTS. Environ. Sci. Technol., 4(7):554-561, July 1970.

About 2.2 million long tons per year of sulfur is contained in the sulfur oxide gases generated in the operation of copper, zinc, and lead smelters in the western United States. Nearly 23% of this is recovered, mostly as sulfuric acid. A study was made to identify and evaluate the technological and economic problems associated with controlling the sulfur oxide emissions of these smelting operations. Three processes for control and by-product recovery were considered: the contact sulfuric acid process, the Cominco absorption process, and the ASARCO reduction process. All three are adversely affected by the low percentage of sulfur in the exhaust gases. Similarly, all are limited in optimum size, since the capital investment for larger operations off-sets the reduction in operating cost. Of the three processes considered, the contact sulfuric acid process is the least costly, both in terms of initial cost and operating cost.

21324

Kato, Yujiro

PLANS AND OPERATIONAL EXAMPLES ON FILTER TYPE DUST COLLECTOR SYSTEM AT VARIOUS INDUSTRIES (VI). THE ROLE OF BAG FILTERS IN THE METALWORKING INDUSTRY. (Gyoshubetsu ni miru rokashiki shujin sochi no keikaku to unten jisshi rei (VI). Kinzoku kogyo ni okeru baggu firuta). Text in Japanese. Kogai to Taisaku (J. Pollution Control), 4(10):663-668, Oct. 15, 1968.

The operational conditions of bag filters used for emission control in the metalworking industry are illustrated by examples. In the zinc refining industry, bag filters are used at various points. The baghouse for the independent electric power plant which is provided to allow the exhausted material to cool down is one example. Another is the baghouse for controlling emissions from a smelting furnace exhaust. The applications of bag filters to the aluminum industry is illustrated by the baghouse used to control emissions from an alumina coveying process. In a powdered lead manufacturing plant, a complete dust collector has to be provided since the lead dust is extremely toxic and cannot be allowed to escape into the atmosphere. Complete hooding is also necessary. In the nonfer-

rous metal working industry, emissions are commonly worth recovering. High efficient dust collectors are adequate for this purpose. In the iron and steel industry, the collected material from the exhaust is generally of little value, but dust collectors are necessary for air pollution control. Their use is typified by baghouses equipped for controlling emissions from electric-arc steelmaking furnaces and from electric furnaces for ferro-alloy manufacture. In the metal processing industry, bag filters are also used for controlling emissions from various processes. An example is the baghouse equipped for controlling emissions from the finishing process of iron casting.

23530

Lepsoe, R. and W. S. Kirkpatrick

RECOVERY OF SULPHUR FROM SULPHUR DIOXIDE. Pulp Paper Mag. Can. (Quebec), vol. 39:20-22, 54, Jan. 1938. (Also: Trans. Can. Inst. Mining Meet., vol. 15:399-404, 1937.)

Sulfur dioxide recovery operations to produce pure sulfur at a lead and zinc smelting plant are outlined. The production involves three main operations. The first consists of absorption of the SO2 The roaster gas is cleaned and passed through one or more absorbing towers in contact with a solution of ammonium sulfite and ammonium bisulfite, concentrating the gas to about 0.1% SO2 or less. The second step involves liberation of the SO2 gas. The sulfite solution is passed down a packed tower and mixed with sulfuric acid previously used to dry the evolved SO2 gas. At the base of the tower is ammonium sulfate solution with a small amount of SO2 included; the latter is driven off by blowing steam directly into the solution. The third step involved reduction of the SO2 gas to elemental sulfur. The SO2 gas and pure oxygen enter a reduction furnace; on leaving the coke-bed, the gases are mainly CO2 and elemental sulfur gas, plus carbon oxysulfide and some carbon monoxide. To this is added SO2 to react with the carbon oxysulfid before it passes into the catalyst column where this reaction takes place. From the columns, the gases pass through waste-heat boilers where liquid sulfur is recovered; this liquid is eventually solidified for marketing.

24321

ELEMENTAL SULPHUR. EXTRACTION AND REDUCTION OF SULPHUR DIOXIDE FROM ROASTER GASES AT TRAIL. Can. Chem. Process, 26(3):138-139, March 1942.

Methods adopted for concentrating the sulfur dioxide from zinc and lead roaster gases, and reducing it to elemental sulfur, are described. In the concentration process, cleaned and cooled roaster gas flows either countercurrent or concurrent to a circulating solution of ammonia monosulfite and ammonium bisulfite through four absorbing towers, reducing the SO2 concentration from about 6 to 0.15%. The only product of the absorption systems is a concentrated solution of ammonium bisulfite, from which SO2 is released by two processes, acidification or exorption. The reduction to sulfur is accomplished by passing the concentrated SO2 through incandescent coke and then through catalyst columns. The gaseous sulfur is condensed out as mist and liquid and recovered as liquid in Cottrell treaters. After removal of any occluded carbon from the molten sulfur, it is pumped into storage tanks where it solidifies as a yellow mass of over 99.99% purity.

24553

Welch, Harry V.

COLLECTION OF LEAD AND ZINC DUSTS AND FUMES BY THE COTTRELL PROCESS. Trans. AIME (Am. Inst. Mining, Metallurgical, and Petroleum Engr.), vol. 121:304-338, 1936. 42 refs.

A review of the historical background of Cottrell precipitators and a discussion of the theory of conditioning blast furnace and Dwight-Lloyd gases is followed by a summary of the design, operation, and application of various Cottrells. Included are the exposed pipe, submerged pipe, plate, rod-curtain, screen, and cylindrical-rod designs. Collection of lead and zinc dusts and fumes by the Cottrell process at a selected number of representativ smelters is described.

25589

Kirkpatrick, S. D.

TRAIL SOLVES ITS SULPHUR PROBLEM. Chem. Met. Eng., 45(9):483-485, Sept. 1938. 2 refs.

The iron and zinc concentrates used at the Trail Smelter average about 400 tons of sulfur per day, which when roasted yield gases containing from 0.7 to 6.8% sulfur dioxide. In the past, all but 10% of the sulfur had been recovered as sulfuric acid for use by the company's fertilizer plant. Now an elementary sulfur recovery plant has been built to recover the remaining sulfur. In essence, this sulfur recovery process consists of absorbing the SO2 from the roaster gases in ammonium sulfite solution from which it is eliminated as 100% SO2 by treatment with concentrated sulfuric acid. Pure SO2 is then reduced by incandescent coke to elemental sulfur which is refined to 99.99% brimstone, that is sold to the paper and pulp industry and to farmers for crop dusting. Equipment used in the process includes lead towers, packed with wood-plank for absorption of SO2; iron plate-and-frame filter presses for removing any solids carried over from the roasters; and lead towers, packed with acid-proof brick, for eliminating SO2 from the absorbing solution. The coke- fired reduction furnace is essentially a gas producer in which large amounts of carbon oxy-sulfide are formed. To convert the carbon oxy-sulfide to sulfur and carbon dioxide, exit gases from the reduction furnace are passed to a catalyst column where the reducing reaction is completed. The gases are then cooled, most of the sulfur condensed as a liquid, and what is remaining is precipitated as a mist in Cottrell treaters.

26107

Ichijo, M.

TECHNOLOGY OF POLLUTION-CONTROL IN ZINC AND LEAD SMELTING. (Aen oyobi nanari serien ni okeru kogai boshi gijutsu). Text in Japanese. Kinzoku (Metals) (Tokyo), 41(1):118-121, Jan. 1 and 15, 1971.

Cadmium production by zinc smelting is a serious pollution problem, even though the amount generated is very small (about 1/400 of zinc). The pollutant is a source of contamination whether discharged with smelter effluent or contained in solid waste. Though present in an even smaller proportion, cadmium is also found in lead; and both lead and zinc production are increasing. Flow sheets are given for both wet and dry zinc smelting processes and lead smelting processes. Attempts to recover cadmium and recycle it to the smelting operation have not significantly reduced emissions. Currently the effluent is being treated with calcium carbonate or calcium hydroxide. A process for recovering these compounds as sulfides is in the development stage. Other control methods under study are ion exchange, multi-stage flush condensation, and the Duval and cyanide methods used in copper smelting.

27470

FLUIDIZED BEDS--PART I: FLUIDIZED REACTORS BECOMING POPULAR. Can. Chem. Process., 55(2):20, 21, 24, Feb. 1971.

Canada's pulp and paper and metallurgical industries are increasingly turning to fluidized-bed reactor systems since these offer thermal efficiency and uniformity of reactor environment. Basically, a fluidized bed functions when a bed of solid particles is set in fluid motion by directing a stream of gas, under carefully controlled conditions, up through the bed. The gas stream forces a passage between the particles, setting them in homogeneous motion and causing the solids to take on a fluid character. Advantages resulting from this fluidized state are temperature control, continuity of operation, hea transfer, and catalysis. A new application of the fluidized-bed reactor is the reduction of zinc concentrates to calcine. One plant has solved the problem of removing the calcine dust from sulfur dioxide-containing roaster gases by a combination cyclone-electrostatic precipitator system. The roaster plant is provided with control instrumentation for sulfur dioxide analysis and precipitator electrical data. An important feature of the fluidized bed reactor in iron ore reduction is the reduced gas throughput and resulting higher SO2 concentrations in the gas which permit more efficient acid production. The heat of reaction in this type of reactor is commonly scavenged to provide process steam.

27597

Semrau, Konrad T.

CONTROL OF SULFUR OXIDE EMISSIONS FROM PRIMARY COPPER, LEAD, AND ZINC SMELTERS--A REVIEW. Preprint, Air Pollution Control Assoc., Pittsburgh, Pa., 39p., 1970. 140 refs. (Presented at the Air Pollution Control Association, Annual Meeting, 63rd, St. Louis, Mo., June 14-18, 1970, Paper 70-97.)

The methods of control of sulfur dioxide emissions from primary copper, lead, and zinc smelters are reviewed. The principal barrier to control is economical rather than technical. The processes of copper, lead, and zinc smelting are described. Method for control and useful recovery of sulfur oxide emissions are placed into 3 categories: systems producing sulfuric acid; systems producing concentrated sulfur dioxide, either for use as such or as an intermediate in production of some other materials, such as sulfuric acid or elemental sulfur; and systems producing elemental sulfur. Processes described include a conventional gas cleaning and conditioning system for a sulfuric acid plant consisting of scrubbing towers and a wet-type electrostatic precipitator, the Asarco DMA absorption system, the Cominco ammonia absorption system the Lurgi Sulfacid process, the Monsanto Cat-Ox process, the Boliden process, the Asarco Brimstone process, the TGS process, and the Claus process.

28267

SULPHURIC ACID, FERTILISERS AND ELEMENTAL SULFUR FROM FURNACE GASES. Chem. Eng. Mining Rev., 30(350):49-51, Nov. 15, 1937.

About 20 tons/day of sulfur is evolved in the zinc roasting section and 160 tons in the lead roasting section at Trail, B. C. About 60% of the content of the zinc gases is fixed directly as sulfuric acid; the balance is absorbed by passing through several towers until the sulfur dioxide content is reduced from 6% to 0.1%. The resulting ammonium bisulfite soulution is then treated in a tower with sulfuric acid; SO2 is liberated and ammonium sulfate solution obtained from which the salt may be crystallized by evaporation. The SO2 gas, together with oxygen from a liquid-air distillation plant, is blown into a modified water-gas producer, where the reaction with incandescent coke produces carbon dioxide and sulfur gas, plus a certain amount of carbon oxysulfide and carbon monoxide. Sulfur dioxide is added to the exit gases in the proportion required to convert the oxysulfide to CO2, and the gases lead to waste-heat boilers and a Cottrell electrostatic plant, where liquid sulfur is produced. Further treatment by electrostatic precipitators raises the grade of the sulfur to 99.95%. Present production of the sulfur plants is 450 tons of sulfuric acid/day and 45 tons of sulfur/day.

28595

Semrau, Konrad T.

FEASIBILITY STUDY OF NEW SULFUR OXIDE CONTROL PROCESSES FOR APPLICATION TO SMELTERS AND POWER PLANTS. PART I: THE MONSANTO CAT-OX PROCESS FOR APPLICATION TO SMELTER GASES. (FINAL REPORT). Stanford Research Inst., Menlo Park, Calif., NAPCA Contract CPA 22-69-78, SRI Proj. PMU-7923, 54p., 1969 (?). 20 refs. NTIS: PB 197166

The Monsanto Cat-Ox system for sulfur oxides recovery is essentially an adaptation of the contact process for sulfuric acid manufacture. The gas containing both SO2 and oxygen is passed through a fixed bed of catalyst at an appropriate temperature, and most of the SO2 is oxidized to SO3. The gas is then passed through an absorption tower, where the SO3 is absorbed in recirculated sulfuric acid. Though developed primarily for use with power plant flue gases, the Cat-Ox system can be used on dilut gas streams (such as smelter gases) containing 2% or less SO2. In the present study, cost estimates were obtained for application of the Cat-Ox system to hypothetical copper and zinc smelters of varying sizes and producing 2% and less SO2. Even with the richest of the gases, the acid production cost would exceed $ll/ton, making the acid noncompetitive with that from alternative available sources. For gases containing less than 2% SO2, acid production costs rise rapidly with decrease in SO2 concentration. Plant size is an additional but much less important factor in acid-production cost.

29328

Rastas, J., E. Nyholm, and J. Kangas

MERCURY RECOVERY FROM SO2-RICH SMELTER GASES. Eng. Mining J., 172(4):123-124, April 1971. 1 ref.

When Outokumpu Oy put on-stream its zinc plant at Kokkola, Finland, about half of the mercury contained in the zinc concentrate went to the sulfuric acid produced, and Outokumpu had to find a method for mercury removal from roaster gases. If roasted in a fluidized bed furnace at 950 C, the mercury sulfide contained in zinc concentrates decomposes and the mercury vaporizes. The heat contained in the gases is recovered in a waste-heat boiler. Dust is separated from the gas with cyclones and electrostatic precipitators, and the gases at a temperature of 350 C go to the sulfatizing unit. The mercury sulfatizer is a brick-lined tower containing ceramic packing; here, the mercury-bearing gases are contacted by a countercurrent flow of strong sulfuric acid which sulfatizes the mercury. Sulfuric acid flows from the bottom of the tower to an intermediate storage tank, from where it is pumped through a heat exchanger and recycled to the tower. Part of the acid is taken from the storage tank to a thickener, where mercury sulfate and selenium compounds are separated from the solution. Zinc and iron salts formed from the dust of the gas are also separated from the acid in the thickener. Gas leaving the mercury sulfatizer at a temperature of 180 C contains less than 0.2 mg/cu Nm of elemental mercury. The gas is then washed with weak sulfuric acid in a venturi scrubber to decrease the temperature to about 70 C and to lower the chlorine content to a level permitted for sulfuric acid production. The underflow

which is obtained when the mercury and selenium compounds are separated from this weak acid in the thickener is combined with the underflow of the thickener of the mercury sulfatizer. Precipitates from the combined underflow are washed with water. The filtered residue is mixed with lime in a certain proportion, and the batch charged to a resistance-heated furnace whose temperature is raised gradually to about 650 C. The mercury compounds decompose, and metallic mercury vaporized is carried out of the furnace together with an air stream.

32260

Lepsoe, Robert

HISTORY OF THE TRAIL SMELTING PLANTS. (Historien om Trail smelteverk). Text in Norwegian. Tidesskr. Kjemi Bergvesen Met., 7(2):22-25, Feb. 1947.

The history of this plant, located in the Canadian province of British Columbia, on the Columbia River just north of the U. S. border is reviewed. The plant produces metallic lead, zinc, cadmium, gold, tin, elemental sulfur, and sulfur dioxide gas (for commercial use). At an earlier period, the company had serious problems with lead poisoning among its workers, but the institution of regular checkups, including blood tests, of workers in contact with lead, combined with proper medical treatments and other personnel policies, has almost eliminated the problem. Extensive research has been done at the plant on the problem of recovering sulfur products from the roasting gases. Among the absorption media tested are zinc oxide, limestone, basic aluminum sulfate, and organic bases. Granulated lead slag has been found extremely effective as an absorbing agent, but at the same time its use is not economically profitable. The basic decision of plant management was to recover sulfur dioxide in a form in which it could be converted to elemental sulfur or sulfuric acid. Reducing SO2 with coke is complicated by the fact that coke is so expensive locally. On the other hand, there is an abundance of carbon monoxide available from thermo electric plants, which can be substituted for the coke.

32319

Konopka, A. P.

PARTICULATE CONTROL TECHNOLOGY IN PRIMARY NON-FERROUS SMELTING. Preprint, American Inst. of Chemical Engineers and Inst. Mexicano de Ingenieros Quimicos, 10p., 1970. 9 refs. (Presented at the American Institute of Chemical Engineers and Institute Mexicano de Ingenieros Quimicos Joint Meeting, 3rd, 0Denver, Colo., Sept. 1970.)

The sources and nature of particulate emissions and control technology in the primary smelting of aluminum, copper, lead, and zinc are described. The high dust concentrations generated by bauxite drying and alumina calcining frequently require multicyclones for preliminary collection, followed by electrostatic precipitation. Installed costs for the combined system are $4.60-$2.30/CFM, at 99+% collection efficiencies. Electrolytic aluminum reduction cells pose a more complicated emission problem: moderate-energy wet scrubbers, glass filter bags, or flushed precipitator installations are used. Representative installed costs for the three methods are $3.00/CFM, $2.00/CFM, and $2.00/CFM, respectively. Dry electrostatic precipitators, preceded by mechanical collectors, are universally applied in copper smelting. Installation costs for the combined equipment are $6.00/CFM for 50,000 CFM flows and $3.00/CFM for 2,000,000 CFM flows. Large lead blast furnaces employ electrostatic precipitators, smaller units use fabric filters. Installation costs of vertical flow pipe-type precipitators in the 100,000 CFM range are $6.00/CFM. Continuous baghouses for smaller volumes cost $5.00/CFM installed. Horizontal flow plate precipitators are used on new zinc sintering machines. Mild-steel construction is common, and installed costs for 50,000 CFM collectors are $3.50/CFM. Emissions from flash roasting of zinc ore are also controlled by plate-type precipitators of mild steel construction. Installed costs are $3.50/CFM.

32461

Kangas, J., E. Nyholm, and J. Rastas

SMELTER GASES YIELD MERCURY. Chem. Eng., 78(20):55-57, Sept. 6, 1971.

A technique was developed which scrubs the sulfur dioxide-rich gases from smelter or roasting operations of mercury before the gas is processed for sulfuric acid production. At the Kokkola plant of Outokumpu Oy (Finland), zinc concentrates are roasted in a fluidized-bed furnace at at temperature of 950 C. Mercury sulfide contained in the concentrate decomposes completely and mercury vaporizes. The heat contained in the gases is recovered in a waste heat boiler, and dust is separated from the gas by means of cyclones and electrostatic precipitators. Mercury-containing gases coming from the electrostatic precipitators at a temperature of 350 C go to the sulfatizing unit. The mercury sulfatizer is a brick-lined tower containing ceramic packing, in which mercury-bearing gases contact a countercurrent flow of strong sulfuric acid. Mercury and selenium are scrubbed from the gas by the acid. Sulfuric acid flows from the bottom of the tower to an intermediate storage tank, it is then pumped through a heat exchanger and recycled to the tower. Zinc and iron salts, as well as chlorides and fluorides, can also be removed in this process. Washing the precipitate, and the production of metallic mercury are mentioned.

32760

Schulz, Ulrich and Ulf Richter

THE INFLUENCE OF TECHNOLOGICAL PARAMETER ON THE COLLECTION EFFICIENCY OF ELECTROSTATIC PRECIPITATORS IN NON-FERROUS METALLURGY. (Einfluss technologischer Parameter auf den Abscheidegrad von Elektrofiltern in der NE-Metallurgie). Text in German. Neue Huette, 16(7):385-390, July 1971. 13 refs.

Experiments were conducted with a hot gas electrostatic precipitator to determine efficient design criteria for application to the non-ferrous metallurgical industry. A sample flow was drawn through the precipitator from waste gases coming from copper, tin, zinc, and lead furnaces. Dust which had remained in the gas after passage through the precipitator was removed with a glass fiber reinforced asbestos paper filter. Efficiency measurements, resistance determinations, and theoretical considerations revealed that the filter temperature and water content of the gases influence the collection efficiency by relationships which are controlled by the specific electric resistivity of dust. In the case of dusts with a resistivity of less than 10 to th 10th power ohm/cm, temperature and dew point influence the collection efficiency via the breakdown voltage and the gas viscosity, regardless of the dust resistivity.

35296

Ichijo, Michio

JAPAN TODAY: POLLUTION-FREE METALLURGY. Mining Mag. (London), 125(5):471-474, Nov. 1971. 10 refs.

A pollution-free process for recovery of various metals from Kuroko ore is described. The ore is first separated by a flotation process to produce copper, lead, zinc, iron, and slime bulk concentrates, plus tailings. The copper concentrate is then treated by a dry method for extraction of crude copper. Iron concentrate is treated by the Kohwa process to obtain hematite pellets. Lead and zinc dust from the copper concentrate and vaporized copper, lead, and zinc chlorides from the iron concentrate are treated in a gas-absorbing neutralization tank and then separated from the transparent solution by precipitation. Lead and zinc concentrates and slime bulk concentrates are oxidized and leached with ferric chloride solution, separating the precipitate from the transparent solution. Sulfur is precipitated as elemental sulfur, then the leached residue is recycled to the flotation process. The transparent solution, after leaching with ferric chloride, contains copper, lead, zinc, and other metallic ions. High purity metals are obtained by amalgam phase exchange in combination with amalgam electrolysis.

35303

Cattelain, Claude

METHOD FOR TREATING ZINC BLAST FURNACE GASES. (Metallurgical Processes Ltd., Nassau (Bahamas) and Imperial Smelting Corp. Ltd., London (England)) U. S. Pat. 3,592,631. 4p., July 13, 1971. 8 refs. (Appl. April 11, 1968, 2 claims).

A method is presented for conveying zinc blast furnace exit gases from a condenser to a scrubbing tower by means of a dry crossover duct. Prior practice was to use a crossover duct in the form of a downcomer to link the top of the condenser with the bottom of the scrubbing tower. This crossover duct was irrigated with water to attempt to minimize accretion of lead and zinc oxides. However, accetions were still a problem. In the present process, the duct is sloped upward towards the scrubbing tower to return liquid metal to the condenser. The scrubbing tower includes sprays for cooling and saturating the gases in order to avoid accretion at the end of the duct or tower. (Author abstract modified) 0

37750

Schulz, Ulrich and Ulf Richter

INFLUENCE OF TECHNOLOGICAL FACTORS ON THE DEGREE OF SEPARATION OF ELECTRIC FILTERS IN NON-FERROUS METALLURGY. (Einfluss technologischer Parameter auf den Abscheidegrad von Elektrofiltern in der NE-Metallurgie). Text in German. Neue Huette, 16(7):385-390, July 1971. 13 refs.

The flying dust generated in non-ferrous metallurgical furnaces is mostly composed of oxidized particles of zinc, lead, tin, antimony, and arsenic. Sheet-type filters and electrostatic precipitators are used for removal and recovery of these dust types. Due to the generally high specific electric resistance of the dust, the process can be carried out effectively only by adhering to certain values of precipitation temperature and water content of the gas phase. To establish design parameters for the construction of precipitators for the non-ferrous metal industry, the precipitation rate of waste gases derived from various metallurgical furnaces for copper, zinc, tin, and lead was measured by a laboratory-type electrostatic precipitator. The influence of precipitation temperature and water content of the gas phase on the precipitation rate was investigated. The results of measurements of precipitation rates and electric resistance of the separated dust material, in combination with theoretical considerations, lead to the conclusion that with dust of a specific electric resistance of less than 10 to the 10th ohm cm, the precipitation rate is influenced by temperature, dew point of gas, viscosity of gas, and voltage of electric field, independent of the specific electric resistance of the dust. Above 10 to the 10th and up to 10 to the 11th ohm cm, the precipitation rate is related to the specific electric resistance of the dust.

40760

Bureau of Mines, Washington, D. C.

CONTROL OF SULFUR OXIDE EMISSIONS IN COPPER, LEAD AND ZINC SMELTING. Bureau of Mines Information Circ., no. 8527:1-62, 1971 6 refs.

Removal of sulfur oxides from copper, lead, and zinc smelter gases will require substantial capital investment. The copper smelting industry anticipates expenditures of $600 million in order to conform to a 10% standard. The lead and zinc industry is expected to spend at least $100 million. According to industry specialists the smelting cost of copper may rise 4 cents/lb from current levels of 4 to 6 cents/lb. Lead is expected to increase 2 to 4 cents over the current cost of 2 cents/lb. Zinc may increase 1.5 cents/ lb from its current price of 6 cents/lb. Companies may find it difficult to pass the cost on to the ultimate consumer. Controversy has arisen between the metals industry and governmental control agencies over the status of stack gas desulfurization processes. New markets for sulfuric acid produced during effluent gas scrubbing must be discovered. Air pollution regulations and emission standards are mentioned. Sulfur dioxide control methods include tall stacks, conversion to H2SO4 by the contact method, absorption, lime and limestone scrubbing to yield sulfur compounds, and reduction of SO2 to elemental sulfur.

44025

McCrea, D. H., G. J. Cinquegrane, R. J. Leister, and A. J. Forney

EVALUATION OF SOLID MINERAL WASTES FOR REMOVAL OF SULFUR FROM FLUE GASES. Bureau of Mines, Washington, D. C., and IIT Research Inst., Chicago, Ill., Proc. Miner. Waste Util. Symp., 3rd, Chicago, Ill., 1972, p. 153-160. 5 ref. (March 14-16.)

The U. S. Bureau of Mines has been investigating the use of solid mineral wastes for removing sulfur oxides from flue gases. A literature survey identified more than 20 materials that are available in large quantity, have thermodynamic potential of reacting with SO2, and can be supplied to the North Central United States for less than $20/ton. Reactivity of these materials toward SO2 was determined experimentally at 130-700 C. In most cases, SO2 was absorbed, but capacity and rate of absorption were low. However, two waste products--red mud and lead-zinc ore tailings--absorbed substantial quantities of SO2. Lead-zinc ore tailings consist primarily of dolomitic carbonates. Their use was evaluated in differential kinetic experiments and by injection into a small pulverized coal-fired furnace. Results showed that injection of the tailings is probably less attractive than injection of limestone. Red mud, the byproduct of bauxite refining, was also studied in differential kinetic experiments and by injection into the furnace. Results showed that, when the injection method is used, the short residence time prevents efficient SO2 removal. Experiments demonstrated, however, that if a reactor is employed to increase residence time, a high degree of SO2 removal can be obtained at 550 C. The red mud can be thermally regenerated at 650 C. A conceptual regenerable process has been suggested. (Author abstract)

44367

Ichijo, Michio

ZINC, COPPER, AND CADMIUM REFINERIES. (Aen, do, kadomiumu seirenjo). Text in Japanese. Kinzoku Zairyo (Metals in Engineering), 12(5):20-26, May 1972. 14 refs.

A general discussion is given of the present status of pollution control in various metal refineries. In 1969, only 30.7% of the total sulfur dioxide from zinc, copper, and cadmium refineries in the U. S. was recovered, the other 69.3% being released to the atmosphere. A control policy has since been formulated. Sulfur dioxide in flue gas is usually recovered as sodium sulfite, ammonium sulfate, sulfuric acid, gypsum, or high concentrated SO2. There is a wide range of dust-generating sources. The problem is being gradually solved through use of cyclones, bag filters, electrostatic precipitators, scrubbers, and other control equipment. The treatment of waste water and sludges, and the removal of mercury and arsenic, are also described. Processes for the removal of mercury from flue gas and the wet treatment of pyrites are illustrated in flow charts.

C. MEASUREMENT METHODS

33045

Triplett, Gary

ESTIMATION OF PLANT EMISSIONS. Preprint, p. 15-27. 1970 (7). 21 refs.

There are times when it is not possible or practical to determine emission rates by stack sampling; in these cases emission rates may be estimated by utilizing available emission factors. An emission factor is the statistical average of the mass of contaminants emitted/unit quantity of material handled, processed, or burned. The emission factor may also be expressed as the quantity of contaminant/unit quantity of final product or effluent volume. These factors have been developed through stack testing or by material balance calculations. Emission factors are normally given in terms of uncontrolled emissions. Therefore, the type and effectiveness of control equipment must be considered when calculating emissions from controlled sources. Particle size distribution and effective stack height should also be considered. Emission factors are given for coal, fuel oil, natural gas, and wood burning; solid waste disposal; incinerators; paint manufacturing; the food and agriculture industry; primary metallurgical processing including iron and steel manufacturing, open hearth furnaces, basic oxygen furnaces, electrical arc furnaces, and blast furnaces; smelting and foundries for aluminum, brass, lead magnesium, steel, and zinc; mineral processing of asphalt, calcium carbide, cement, concrete, glass and lime; petroleum production, and the kraft pulp industry. (Author abstract modified)

D. AIR QUALITY MEASUREMENTS

10517

Robinson, E. and R. C. Robbins

SOURCES, ABUNDANCE, AND FATE OF GASEOUS ATMOSPHERIC POLLUTANTS (FINAL REPORT.)Stanford Research Inst., Menlo Park, Calif., SRI-P 6755, 123p., Feb. 1968. 120 refs.

An analysis of the sources, abundance, and fate of gaseous atmospheric pollutants is presented, considering three families of compounds: sulfurous, nitrogenous, and organic; and two inorganic carbon compounds: carbon monoxide and carbon dioxide. With the exception of CO2, similar patterns of analyses of these materials a followed and rather detailed analyses are produced. The presentati of CO2 is only a brief review of the current state of thinking. Included are estimates of annual world-wide emissions of pollutants SO2, H2S, CO, NO2, NH3, and organics. The magnitudes of the natura emanations of a variety of materials have also been considered, although the means of estimating these emissions are very crude because so little study has been made of emissions from other than urban air pollution sources. Sulfur compounds, in the form of SO2, are currently the most topical of the numerous air pollutants. Sulfur enters the atmosphere as air pollutants in the form of SO2, H2S, H2SO4, and particulate sulfates; and as natural emanations in the form of H2S and sulfates. Among the various sources of CO, automobile exhaust accounts for more than 805 of the estimated worl wide CO emission. The major sources for the gaseous nitrogen compounds are biological action and organic decomposition in the so and perhaps in the ocean. Aerosols containing NH4 ions and NO3 ion are formed by atmospheric reactions involving the various gases. Major contributions of hydrocarbons include natural CH4 emissions from flooded paddy areas, terpene-class organics evolved by vegetation, and pollutant emissions. A brief review of present understanding of CO2 in the atmosphere indicates a clear example of situation where pollutant emissions are significant enough to cause measurable changes in the ambient concentrations.

26054

Ministry of Health and Welfare, Tokyo (Japan), Public Nuisance Section

REPORT OF THE SURVEY OF AIR POLLUTION OF ANNAKA AREA IN GUNMA PREFECTURE. (Gunma-ken Annaka chiku kankyo osen chosa kkeka hokoku-sho). Text in Japanese. 108p., June 1970.

In May and October in 1969, oxidized sulfur, suspended dust, metallic ingredients, and meteorological conditions (only in May) were surveyed. In Annaka, a zinc smeltery is located on a steep slope, and the lay of the land is complicated; the air current there is considerably disorderly, and ordinary diffusion equations such as Sutton and Bosanquet's cannot be applied. Also, atmospheric temperature of the plateau and the basin goes into reverse; this influences atmospheric pollution conspiciously in winter. The highest amount of sulfur dioxide was 0.04 ppm; less than 0.03 ppm was measured at most of the stations. The hourly average of 8 daytime hours was a maximum of 0.1 ppm at a spot withi 500 meters on the south side of the zink smeltery. One of the characteristics of this area is that a high level of pollution for a short period occurs frequently. The possible cause of this is that the smoke producing equipment is not in good condition for emission and diffusion. Pollution did not always correspond with the amount of smoke emitted. As to the extension of the polluted area, the south side of smoke emitted. As to the extension of the polluted area, the south side of the smeltery showed a remarkably low level 600-700 m from the smeltery; but on the east side, a considerably high level of pollution remained more tha 1 km from the smeltery. The average of total amount of suspended dust was 214 micrograms/cu m, the highest measured at the measuring stations was 365 micrograms/cu m, and the daily highest was 539 micrograms/cu m. The average amount of cadmium was 0.10 micrograms/cu m (May) and 0.04 micrograms/cu m (October). The average amount of lead was 1.13 micrograms/cu m (May) and 0.68 micrograms/cu m (October); the amount of lead at several measuring stations was remarkably higher than that of the other cities and towns. The amount of cadmium and lead decreased in October. No relation was found between the hourly changes of dust and SO2, but some relation of the changes of the hourly average of the two during the 8 daytime hours was recognized.

26372

Ministry of Health and Welfare, Tokyo (Japan), Public Nuisance Section

STUDY OF POLLUTION FROM ANNAKA ZINC SMELTER. 6p., Nov. 1969. Translated from Japanese. Belov and Associates, Denver, Colo., 7p., March 27, 1970.

The results of a survey in May 1969 of emissions from a zinc smelter are presented. Typical daily averages of sulfur oxides were 0.02-0.03 ppm. Suspended particulates were measured at 250 mg/cu m for one 24-hour period, going up to a high of 300 mg/cu m on another day. The daily average cadmium concentratio was 0.03-0.19 mg/cu m. Particulates decreased with increasing distance from the smelter, as did cadmium concentration to a very marked degree. Data collected in the survey are given in tabular form for 13 stations.

E. ATMOSPHERIC INTERACTION

12777

McKee, Arthur G. and Co., San Francisco, Calif., Western Knapp Engineering Div.

SYSTEMS STUDY FOR CONTROL OF EMISSIONS. PRIMARY NONFERROUS SMELTING INDUSTRY. (FINAL REPORT). VOLUME III: APPENDICES C THROUGH G. Contract PH 86-65-85, Rept. 993, 114p., June 1969. 130 refs. CFSTI: PB 184 886

A systems study of the primary copper, lead, and zinc smelting industries is presented to make clear the technological and economic factors that bear on the problem of control of sulfur oxide emissions. Various sulfur oxides control methods, including scrubbing, absorption, and reduction, are matched with smelter models to determine optimum control and production combinations. A precise analysis of the pollution potential of an individual smelter requires meteorological data for the specific smelter site. The variables that can be considered in such a topographical analysis include inversion frequencies, monthly mean maximum mixing depths, surface winds, and general airflow conditions. An analysis of the U. S. markets for zinc, lead, and copper is presented, as well as markets for sulfur byproducts. A literature review of control methods for sulfur oxide emissions from primary copper, lead, and zinc smelters is included.

F. BASIC SCIENCE AND TECHNOLOGY

13534

Mackiw, V. N.

CURRENT TRENDS IN CHEMICAL METALLURGY. Can. J. Chem. Eng., 46(1): 3-15, Feb. 1968. 52 refs.

Recent developments in hydrometallurgy and pyrometallurgy are reviewed. Some processes presently in commercial operation and some in the developmental stage are presented from the standpoint of extraction of metals and from their fabrication into useful materials. The chemical reactions of various commerical processes are shown both graphically and chemically. New processes are presented for the treatment of Zn Cu, and Pb concentrates, complex Pb-Zn, Cu, FeS2 bulk concentrates, and Zn plant residues. A combination of roasting and hydrometallurgy for the recovery of molybdenum from molybdenite is displayed diagramatically. Laterite treatment and other investigations and reactions are reviewed. It is concluded that new products from new processes will evolve economically through a new technology.

14090

Umetsu, Yoshiyuki and Shinichiro Suzuki

ON THE DECOMPOSITION OF ZINC FERRITE BY ROASTING IN SO2-02-N2 ATMOSPHERE. (Atetsu aen no SO2-02-N2 funiki ni yoru bunkai). Text in Japanese. Nippon Kogyo Kaishi (J. Mining Met. Inst. Japan), vol. 68:529-532, 1952. 4 refs.

Zinc ferrite is easily decomposed by roasting from 600 to 800 C in an SO2-02-N2 atmosphere; the roasting temperature is dependent on the partial pressure of SO2 in the atmosphere. Zinc sulfatizes more rapidly than iron. Although the formation of water-soluble iron decreases with a rise in roasting temperature, a certain amount of iron is still soluble at high temperatures. (Author abstract modified)

17529

Watanabe, Motoo and Toshiaki Yoshida

STUDIES ON ROASTING SULFIDE ORES. (II) ROASTING OF ZNS IN THE ATMOSPHERE WITH HIGH PARTIAL PRESSURE OF SO2. (Ryukako no baisho ni kansuru kenkyu (dai 2 ho) Aryusangasu bunatsu no takai kiken deno ryukaaen no baisho). Text in Japanese. Tohoku Daigaku Senko Seiren Kenkyusho Iho (Bull. Res. Inst. Mineral Dressing Met.), 18(2):131-140, Dec. 1962. 5 refs.

Experiments were performed on roasting zinc sulfide at 450 to 750 C in mixed gas atmospheres of 13 to 18% of O2, 12 to 35% of SO2, and in the air. The sample was prepared by recrystallizing a reagent of extra pure grade in a process involving precipitation from ammonium acetate buffer solution. Its analysis was 65.84 Zn and 31.93% S (Zn/S equals 2.06). The theoretical values are 67.09, 32.91, and 2.03 respectively. The products, at low temperature or in the gas containing a large quantity of sulfur dioxide, are rich in the basic sulfate or in zinc sulfate, but most of those produced by roasting at high temperatures are zinc oxide. When zinc sulfide was roasted at high temperature, and in the atmosphere containing much sulfur dioxide, zinc oxide was produced. When zinc sulfide almost disappeared, zinc oxide turned into a basic sulfate by the gas contained in the atmosphere. When roasting was continued, the basic sulfate changed to zinc sulfate. Weight change and the rate of reaction are graphically shown as a function of reaction time for several kinds of the mixed gas atmospheres tested.

19617

Horvath, Zoltan

STUDY OF THE THERMODYNAMICS OF REACTIONS OCCURRING DURING THE DEAD ROASTING OF SPHALERITES AND PYRITES. (A szfalerit es pirit oxidalo porkolesenel lejatszodo reakciok termodinamikai vizsgalata). Text in Hungarian. Kohasz. Lapok, 10(4):163-176, 1955. 6 refs.

The thermodynamics of a number of metallurgical reactions are discussed: the reaction of zinc sulfide with atmospheric oxygen to form zinc oxide and sulfur dioxide; the oxidation of SO2 to SO3; the reaction of ZnO with SO3 to form ZnSO4; the pyrite roasting reaction, which is the decomposition of FeS2 to form FeS and S2; oxidation reactions which involve FeS and S2, yielding FeO, Fe2O3, Fe3O4, SO2, and SO3; various reactions between sulfur trioxide and the sulfides and oxides of iron; the oxidation of FeO to Fe2O3 and Fe3O4; the reaction between FeO and Fe2O3, forming Fe3O4; the oxidation of FeSO4 to Fe2(SO4)3 and Fe2O3; the decomposition of the latter two products to form sulfur trioxide and oxides of iron; the oxidation of FeS2 to form sulfur dioxide and oxides of iron.

23798

Ingraham, T. R. and H. H. Kellogg

THERMODYNAMIC PROPERTIES OF ZINC SULFATE, ZINC BASIC SULFATE, AND THE SYSTEM ZN-S-O. Trans. AIME (Am. Inst. Mining, Metallurgical, and Petroleum Engr.), vol. 227:1419-1426, Dec. 1963. 19 refs.

The total gas pressure developed from decomposition of either zinc sulfate or zinc oxide-2ZnSO4 in a closed system was measured. A flexible Pyrex bellows was used to separate the reaction gas mixture (SO3, SO2, and O2) from the mercury in the manometer, and thus prevent corrosion of the mercury by SO3. In addition to the decomposition-pressure measurements a number of auxiliary experiments involving differential thermal analysis, thermogravimetric analysis, and x-ray diffraction were made. Three anhydrous zinc sulfates have been identified: ZnSO4(alpha), stable below 1007 K; ZnSO4(beta), stable above 1007 K; and ZnO-2ZnSO4. DTA measurements on ZnSO4 consistently show a sharp and reversible endothermic peak at about 1007 K, indicative of crystal transformation. Availability of reliable high temperature equilibrium data for the various zinc sulfates makes possible the construction of the thermodynamic phase diagrams for the ternary system, showing the stable univariant and bivariant equilibrium relations. In the temperature interval 900-1300 K, only one true invariant point is found: that resulting from the crystal transformation in ZnSO4 at 1007 K. The other apparent invariant point

at 1181 K results from the arbitrary selection of 1 atm pressure to divide the fields of stability of liquid and gaseous zinc. Another peculiarity of the Zn-S-O system is that the univariant equilibria exhibit SO_2 pressures which are either too high or too low for direct measurement. Application of these diagrams to problems of roasting zinc concentrates is discussed.

G. EFFECTS-HUMAN HEALTH

03421

. H. H. Schrenk, H. Heimann, G. D. Clayton, W. M. Gafafer, H. Wexler

AIR POLLUTION IN DONORA, PA. (¼EPIDEMIOLOGY OF THE UNUSUAL SMOG EPISODE OF OCTOBER 1948, PRELIMINARY REPORT). Public Health Bulletin No. 306. 1949. 203 pp. GPO, HEW

In the latter part of October 1948, Donora, Pennsylvania, a town of about 13,000 population, containing a zinc plant and a steel and wire plant, experienced a large number of acute illnesses and 20 deaths during a heavy smog. This report is based upon a carefully made epidemiological study, approached from the biological, the engineering, and meteorological point of view. The data collection began after the episode was over and included: (1) Studies of acute morbidity by house-to-house vanvass, records of fatal and hospitalized patients, and finally, study of general morbidity; (2) Study of chronic morbidity by dental examinations of school children, by certain chest roentgenograms, and morbidity of selected groups of individuals; (3) Study of mortality records of the community and comparing them with similar records of neighboring towns; (4) Atmospheric studies of air pollutants; (5) Evaluation of industrial plant effluents; (6) Evaluation of air contaminants from other sources; (7) Description of the topography of the valley in which the town is located; (8) Micrometeorological studies of the valley; (9) Description of the weather during the acute episode in October, 1948. Detailed descriptions of the methods used are presented since it was believed they would be useful to other making similar studies. The study showed that the cause of the episode was an accumulation in the atmosphere of chemical irritants, this accumulation resulting from the weather inversion which existed in this part of the country during the fateful days. The parts played by all sources of chemical air contamination are discussed. A section is devoted to discussing the specific agent or agents probably responsible for the illnesses, and it is deduced that no one agent can be indicated. It was likely that it was due to a chemical irritant (possibly sulfur dioxide) plus particulate matter, although, because of the lack of knowledge about the toxic effects of low concentrations of the irritant gases, this cannot be said with certainty.

32842

McCaull, Julian

BUILDING A SHORTER LIFE. Environment, 13(7):2-15, 38-41, Sept. 1971. 48 refs.

Cadmium pollution of the environment is reviewed with respect to basic characteristics, emission sources, uses, concentration levels, and effects on human health. Cadmium dust, fumes, and mist are emitted during the refining of zinc, copper, and lead, as well as during extraction of cadmium. These processes released an estimated 2.1 million pounds (45% of total emissions) into the air in 1968. The single largest source was the roasting and sintering of zinc concentrates. Incineration or disposal of cadmium-containing products contributed 52% of total emissions. The processes included electroplating, recycling of scrap steel, melting down scrapped automobile radiators, and incineration of solid wastes. Cadmium concentrations in the waterways, tap water, food, vegetation, soils, and certain commercial products (fertilizers) were determined. The toxicity of cadmium, levels of ingestion and retention in the body, and correlation with hypertension, liver damage, bone disease, emphysema in industrial workers, cancer, and kidney impairment are examined.

H. EFFECTS-PLANTS AND LIVESTOCK

16637

Ranft, H.

EVALUATION OF A PREVIOUS PLANTING EXPERIMENT WITHIN THE RANGE OF THE ZINC SMELTER AT FREIBERG. (Vyhodnoceni starsiho pokusu s vysadbou v dosahu zinkove hute u Freibergu). Scientific and Technical Society, Prague (Czechoslovakia), Agriculture and Forestry Section, Proc. Conf. Effect Ind. Emission Forestry, Janske Lazne, Czechoslovakia, 1966, p. XV-1 to XV-15. (Oct. 11-14.) Translated from Czech. Franklin Inst. Research Labs.. Philadelphia, Pa., Science Info. Services, April 24, 1969.

A planting experiment on 10 ha of 40 tree and shrub species which was started i1935 in an area of emission attack from a metallurgical plant at Freidberg in Saxony was evaluated. The experiment was northwest of the plant at 400 m above sea level on a flat plain which slopes eastward to the Mulda valley. The basic stratum is gray gneiss; the soil is medium-to-deep, quite loamy, and exhibits medium sorption and nutrient values. The trees and shrubs were planted in small stands, also in rows and mixed groups, or former agricultural land. The prevailing winds were from southwest to northwest and the growing stands were injured only slightly by the stack gases from the metallurgical plant. After the beginning of the operation of a new zinc refinery which was located a few hundred meters northwest, an increased attack was evidence by SO2, SO3, and iron oxide dust containing waste material. The iron oxide dust did not prove harmful. Short-term measurements gave peak values of more than 1.2 mg SO2/cu m of air. Injuries affecting the size of leaves and fascicles, their color, with necrosis and inhibition of growth of foliage and fascicles was observed. The extent of current damage was determined. Measurements of height and circumference, together with borings, confirmed the more or less large decrease in yields from various representative varieties of woody plant found in the area. Smoke damage on trees and shrubs, based on damage manifestations and yield decrease, were graded and were listed.

27489

Kobayashi, Jun, Fuji Morii, Shigeki Muramoto, and Susumu Nakashima

EFFECT OF AIR AND WATER POLLUTION ON AGRICULTURAL PRODUCTS BY CD, PB, ZN ATTRIBUTED TO MINE REFINERY IN ANNAKA CITY, GUNMA PREFECTURE. (Gunma-ken Annaka-shi no seirensho ni yoru nosakubutsu nado no junkinsoku (Cd, Pb, Zn) osen ni tsuite). Text in Japanese. Nippon Eiseigaku Zasshi (Jap. J. Hyg.), 25(4):364-75, Oct. 1970. 30 refs.

In an investigation of air and water pollution by zinc, lead and cadmium discharged from the zinc refinery in Annaka city, Gunma prefecture, agricultural products in the environs were sampled and the contents of the various metals were analyzed. The examinations were carried out twice: in October, 1968 and in June, 1969. The quantities were measured by the atomic absorption analysis method. The contents of the metals in mulberry leaves in the hilly regions 400-2500 m east of the refinery were: Cd 17 - 3.3 ppm. Zn 2590 - 360 ppm, Pb 160 - 41 ppm, and the contents of Cd and Zn showed a regression line, (Zn) equals 141(Cd) - 107, r equal 0.998, indicating a mutual relationship. For agricultural products, the results were: fruit vegetables Cd 8.6 - 0.3 ppm, Zn 150 - 29 ppm, Pb 11 less than 0.4 ppm, root vegetables, Cd 17 - 14 ppm, Zn 530 - 100 ppm, Pb 63 less than 0.02 ppm; leaf vegetables, Cd 61 - 3.2 ppm, Zn 7010 - 380 ppm, Pb 370 - 4.3 ppm. As to barley and wheat, the highest levels were recorded as follows: Cd 6.8 ppm, Zn 310 ppm, and Pb 14 ppm. Moreover, the contents of Pb in barley and wheat growing in the fields more than 1500 m below the refinery showed higher levels than those of Pb in barley and wheat growing in the hilly Yaden region, which is 800 - 1250 m south of the refinery; the fact indicates that the effect of water pollution cannot be ignored. The contents of Cd and Zn in wheat in Yaden and Iwai region showed a regression line, (Zn) equals 41 (Cd) + 50, r equals 0.95, indicating significant relationships. Also in Yaden region, higher levels of metals were found in leaf vegetables compared with root vegetables and fruit vegetables and in Annaka city, rice was not the only polluted agricultural product but leaf vegetables were especially highly polluted.

32335

Schoenbeck, Helfried

THE APPLICATION OF THE TEST PLANT METHOD. A MODIFICATION OF SAURER S PLANT INDICATOR METHOD FOR THE DETECTION OF PLANT DAMAGING IMMISSIONS. (Die Anwendung der Testpflanzenmethode. Ei Modifikation des Saurerschen Fangpflanzenverfahrens zum Nachweis von Pflanzenschaedigenden Immissionen). Text in German. Polska Akademia Nauk, Zaklad Badan Naukowych Gornoslaskiego Okregu Przemyslowego, Mater. Miedzynarodowej Konf., Wplyw Zanieczyszczen Powietrza na Lasy, 6th, Katowice, Poland, 1968, p. 313-325. 9 refs. (Sept. 9-14.)

Proof that damage to vegetation by emissions from a zinc smelter was obtained by cultivating identical plants at various distances downwind from the smelter and in an uncontaminated locality. To eliminate differences in soil and other environmental factors holes were made in the ground, lined with plastic to prevent interaction with the surrounding soil, and filled with loamy sand containing 20 mg Zn/100 g soil plus 11.4 mg Pb/100 g soil (contaminated soil) and 4.0 mg Zn/100 g soil plus 5 mg Pb/100 g soil (normal soil). Both soil types were used side by side in all experimental sites. Summer wheat, beans, oats, and sugar beet were used as experimental plants. Since damage to the control area plants was due only to the contaminated soil, any additional damage in a polluted atmosphere could be ascribed to the effect of atmospheric pollutants. Wheat grain yield at various distances from the smelter was 46-77% lower than the yield in the control area. Other cultures suffered comparably. Generally the damaging effect of air pollution on plant growth was smaller than that of the metal salt pollutants in the soil. The Zn, Pb, and S levels in plant tissues decreased with increasing distance from the zinc smelter.

44497

Buchauer, Marilyn Jordan

EFFECTS OF ZINC AND CADMIUM POLLUTION ON VEGETATION AND SOILS. Rutgers-The State Univ., New Brunswick, N. J., Dept. of Botany, Thesis (Ph.D.), Ann Arbor, Mich., Univ. Microfilms, Inc., 1971, 44p. 106 refs.

The fate of emitted heavy metals and the effects of zinc and cadmium on vascular plants has been investigated and the relative importance of pollution and fire as causal agents of the vegetation damage evaluated at the Lehigh Gap area in Pennsylvania was evaluated. Soil and foliage samples were analyzed by atomic absorption spectrophotometry with up to 8% zinc and 1500 ppm cadmium by weight found in the air-dried, less than two mm fraction soil horizons. Approximately 90% of added metals are retained in the upper 15 cm of the soil. Trees near the smelters contained up to 4500 ppm zinc and 70 ppm cadmium by weight in overdried foliage. Elevated concentrations of zinc were detected in soil and vegetation up to 10 km west and 20 km east of the smelters. In sand culture nutrient solutions, 10 ppm cadmium and 100 ppm zinc were lethal to seedlings of Quercus rubra and Acer rubrum while Arenaria patula tolerated 100 ppm zinc with no visible effects. Forests in burned and unburned areas on Blue Mountain were sampled for density and percent cover of tree, shrub, and herb species. Sassafras albidum and Nyssa sylvatica are among the most common tree species in the severely denuded areas. Nearly all species which normally invade burned areas are absent or rare at Lehigh Gap. High soil metal levels, erosion, and desiccation are the main factors preventing re-vegetation of the barren areas of Lehigh Gap. (Author abstract modified)

46788

Little, P. and M. H. Martin

A SURVEY OF ZINC, LEAD AND CADMIUM IN SOIL AND NATURAL VEGETATION AROUND A SMELTING COMPLEX. Environ. Pollut., no. 3:241-254, July 1972. 19 refs.

Analysis of samples of leaves and soil collected in the Avonmouth area of Severnside, Great Britain, showed the distribution of airborne zinc, lead, and cadmium to be strongly affected by prevailing wind conditions. Levels of zinc, lead, and cadmium in elm leaves collected in October 1971 ranged from 8000, 5000, and 50 ppm dry matter close to a smelting complex, to values of about 200, 100, and less than 0.25 ppm, respectively, at distances of 10-15 km from the factory. The Avonmouth industrial complex includes the largest lead and zinc smelting plant in the world. Determinations of metal content were made using an atomic absorption spectrophotometer, and results of the analyses are presented in the form of concentration contour maps. (Author abstract modified)

46802

Nash, Thomas H., III

SIMPLIFICATION OF THE BLUE MOUNTAIN LICHEN COMMUNITIES NEAR A ZINC FACTORY. Bryologist, 75(3):315-324, 1972. 16 refs.

The effect of zinc factory emissions on lichen communities was investigated. In Lehigh Water Gap near a zinc factory, species diversities of corticolous, saxicolous, lignicolous, and terricolous lichen communities were markedly reduced as compared to the speciied diversities of lichen communities in Delaware Water Gap. Nine lichen species were found in Lehigh Water Gap; 84 were found in Delaware Water Gap. Foliose, fruticose, and crustose species, respectively, were increasingly more tolerant of the conditions around the zinc factory. The effect of factory emissions on the lichen flora was discernible up to 6 km to the west and 15 km to the east of Lehigh Water Gap. (Author abstract modified)

48167

Leibetseder, Josef, Monika Skalicky, Abdul Hakim Said, Alfred Kment, Erich Glawischnig, and Gerd Schlerka

STUDIES OF THE TOXIC EFFECT OF HAY ON CATTLE IN SMOKE-INJURED AREAS. (Untersuchungen ueber toxische Wirkungen von Heu aus Rauchschadengeibieten beim Rind). Text in German. Z. Erzbergbau Metallhuettenwesen, 25(10):498-505, 1972. 21 refs.

In the vicinity of zinc, lead, and sulfuric acid plants in Arnoldstein, Austria, the extent of injuries to the vegetation by the emissions from these plants was determined. The hay from the smoke-injured area was used for feeding experiments with seven test cows for determination of any possible intoxication through the higher lead, zinc, and fluorine intake with the fodder. With the exception of spots on the teeth of about 1/3 of the test cows, no symptoms of intoxication with these elements could be determined. The feeding experiment lasted 6 months. The lead and zinc concentration of the examined hay was above normal, but below the toxic limit. The fluorine concentrations were on the upper limit of the normal values. Clinical examinations including blood tests carried out at 2-week intervals were negative. The lead and zinc concentrations of blood, blood plasma, feces, urine, milk, and hair were below the toxic range. The fluorine concentration in the bones excluded any fluorine intoxication. The milk production of the test animals, however, was significantly lower by 0.64 l/animal/day (average over the total duration of the feeding experiments), compared to the control animals.

J. EFFECTS-ECONOMIC

30696

LeSourd, D. A., M. E. Fogel, A. R. Schleicher, T. E. Bingham, R. W. Gerstle, E. L. Hill, and F. A. Ayer

COMPREHENSIVE STUDY OF SPECIFIED AIR POLLUTION SOURCES TO ASSESS THE ECONOMIC EFFECTS OF AIR QUALITY STANDARDS. VOL. I. (FINAL REPORT). Research Triangle Inst., Durham, N. C., Operations Research and Economics Div., APCO Contract CPA 70-60, RTI Proj. OU-534, Rept. FR-OU-534, 395p., Dec. 1970. 328 refs. NTIS: PB 197647

Air pollution control costs for mobile sources are presented on a national basis and in terms of unit investment and annual operating and maintenance costs as well as total annual operating and maintenance costs. The analyses cover the estimated emissions and control costs for new cars for Fiscal Year 1967 through Fiscal Year 1976. Control costs for each stationary source, except for residential heating, are shown for 298 metropolitan areas by investment and annual expenditures by Fiscal Year 1976. The impact of control on selected industries and the Nation are also determined. Finally, an extensive bibliography is included. The pollutants from mobile sources selected for analysis are hydrocarbons, carbon monoxide, nitrogen oxides and particulates. The six pollutants for which control cost estimates are made for stationary sources are particulates, sulfur oxides, carbon monoxide, hydrocarbons, fluorides, and lead. Emission standards applied are considered stringent in comparison with many currently in use throughout the Nation. Mobile sources include automobiles and light and heavy-duty trucks. Stationary sources studied include solid waste disposal, commercial and institutional heating plants, industrial boilers, residential heating plants, steam- electric power plants, asphalt batching, brick and tile, coal cleaning, cement, elemental phosphorus, grain handling and milling (animal feed), gray iron, iron and steel, kraft (sulfate) pulp, lime, petroleum products and storage, petroleum refineries, phosphate fertilizer, primary non-ferrous metallurgy (aluminum, copper, lead and zinc), rubber (tires), secondary nonferrous metallurgy, sulfuric acid, and varnish. Data essential for defining metropolitan areas, emission control standards, and relevant process and air pollution control engineering characteristics required to support the cost analyses for each source and the cost impact on each industrial process are presented and analyzed in separate appendixes to this report. (Author abstract modified)

K. STANDARDS AND CRITERIA

06580

RESTRICTING EMISSION OF DUST AND SULPHUR DIOXIDE IN ZINC SMELTERS. (Auswurfbegrenzung Zinkhutten.) VDI (Verein Deutscher Ingenieure) Kommission Reinhaltung der Luft, Duesseldorf, Germany-(Sept. 1961). 33 pp. Ger. (Tr.) (VDI 2284.)

Descriptions of installations and processes for the production of zinc which lead to the formation of sulfur dioxide and dust were presented. Factors influencing dust and sulfur dioxide emissions, means of reducing these emissions, and established limits and guide values for permissible dust emissions from new installations are discussed.

14443

Knop, W.

AIR POLLUTION CONTROL IN NON-FERROUS METAL INDUSTRIES. II. PARTICULATE AND GASEOUS EMISSIONS OF THE NON-FERROUS METAL INDUSTRY AND EMISSION STANDARDS. (Luftreinhaltung im NE-Metall-Betrieb. II. Staub-und gasfoermige Emissionen der NE-Metallindustrie und die Emissionsbegrenzung.) Text in German. Metall., 22(12):1266-1271, Dec. 1968. 21 refs.

In this review article, the West German air pollution laws and regulations as applied to metallurgical plants are compiled and discussed. In the aluminum industry, dust arises both in the production of aluminum oxide from bauxite and in the electrolytic furnaces. The most dangerous component of the waste gas is fluoride of which the maximum allowable concentration is 2.5 mg/cu m. Lead refineries emit considerable amounts of dust, up to 15 g/cu m waste gas, which contains metal compounds in the form of sulfates, oxides, sulfides, and coke dust. The pollutants originating in the various steps of lead production are discussed in detail. The threshold limit value (TLV) of lead is 0.2 mg/cu m. Electrometallurgical furnaces for iron and steel alloys emit very fine dusts (less than 0.4 micrometer), typically up to 250 kg/hr at 10,000 kva capacity. Metal oxides predominate, especially iron and silicon oxides. The waste gases of copper ore refineries contain mostly fly dust and sulfur compounds. The dust contains copper, zinc, and sulfur. Typical concentrations at various stages are listed. The TLV of copper is 1 mg/cu m. Emissions of zinc plants are listed, and waste gas and soot emissions of oil, coke, and coal furnaces are discussed in detail. Special problems are posed by scrap metal refineries, where plastics and varnishes cause air pollution. Typical examples are cited.

L. LEGAL AND ADMINISTRATIVE

44265
Gabrisch, R.

DEVELOPMENT AND EFFECTS OF LEGAL REGULATIONS CONCERNING METALLURGICAL PLANTS AND REMELTING PLANTS. (Entwicklung und Auswirkung behoerdlicher Auflagen fuer Metallhuetten und Umschmelzwerke). Text in German. Preprint, Gesellschaft Deutscher Metallhuetten und Bergleute, Clausthal-Zellerfeld (West Germany), 12p., 1972. (Presented at the Gesellschaft Deutscher Metallhuetten und Bergleute-Hauptversammlung, Stuttgart, West Germany, April 26- 30, 1972.)

One hundred and forty-four metallurgical plants and recasting plants existed in the Federal Republic and West Berlin in 1971. The total turnover was about one billion dollars, 0.8% of the entire industrial turnover. Despite this relatively small fraction of the total industrial turnover, the expenditures for air pollution control measures are remarkable. The new regulations which became effective in 1971 tie the licensing of all melting plants for non-ferrous metals to the presence of the most modern air pollution cleaning facilities. Vacuum melting plants and melting plants for up to 50 kg light metals or 200 kg heavy metals and melting plants for precious metals are excluded. In 1964 the Technical Directives for the Maintenance of Clean Air (TAL) were enacted. They demanded that the sulfur dioxide emissions by lead and zinc plants be reduced as far as possible by passing the roasting and sintering gases to a sulfuric acid production plant. The particulate emissions were limited to 400 mg/cu m during continuous operation for waste gases from lead blast furnaces, from lead reverberatory furnaces, and from zinc muffle furnaces. The particulate emission from lead refineries and zinc distillation plants was limited to 200 mg/cu m. Emissions from copper processing could contain as much as 500 mg/cu m dust. In 1966 this limit was reduced to 300 mg/cu m. For secondary aluminum plants a guideline is being worked out which will recommend the limitation of the particulate emissions from all melting aggregates to 150 mg/cu m and from thermal degreasing plants to 100 mg/cu m. In secondary zinc and copper plants, the maximum allowable emission will be limited to 50 mg/cu m because of the toxicity of zinc and copper. The metal recovery from old cables is connected with emission problems which still require a solution. At present no cable burning plant in Germany is equipped with any dust cleaning devices.

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